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THE PEAR LEAF BLISTER MITE AS A CAUSE OF FRUIT-BUD INJURY

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For a number of years many pear orchards in California have suffered considerable damage from dead fruit buds during the winter, weak flowers at blooming time, and russeted, misshapen fruit at harvest. This injury has increased greatly during the past four years and in some cases has resulted in a total loss of crop. The appearance of similar injury on apples in the Sebastopol district in 1931 adds to the economic importance of the problem. Injury to fruit buds and new growth of both Gravenstein and Delicious apples resulted in killing of practically all of the fruit buds in parts of the tree.

The seriousness of the injury caused by this mite, its wide distribution, and the lack of a definite control program has made it of prime economic importance to the pear and apple growers of the state.

The cause of this bud injury was first recorded in California in 1928, though it had been reported in South Africa four years previously. It was found to be a tiny mite, known as the pear leaf blister mite, *Eriophyes pyri* (Pagen.), which also causes the blistering of leaves on pear and apple. Other mites have been taken on apple and cherry but their economic importance has not as yet been determined.

Owing to the type of injury and the difficulty in making the determination, the identity of the species was at first in doubt. After careful anatomical studies in which there were found no structural differences, it was determined to be the common leaf blister mite of the pear. The habits and type of injury, however, are almost totally different from those given for the mite causing the blisters in the leaves. The activity of the mite while under the fruit-bud scales, the killing of the fruit buds, the injury at blossom time, and the lack of

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blisters in the foliage would almost indicate a distinct species, but at present it is considered to be the well-known pear leaf blister mite with new habits, causing a very different type of injury.

THE MITES

Blister mites are not insects, but belong to an order of the class Arachnida and are closely related to the red spider, brown mite, chicken mite, and cereal mites. Because of their exceedingly small size (1/150 inch long) the pear leaf blister mites cannot be seen with the unaided eye. A hand lens with a magnification of 10 or 14 or a

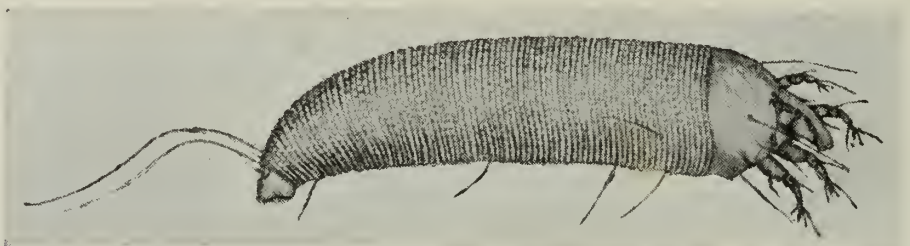

Fig. 1.—Adult pear leaf blister mite, *Eriophyes pyri* (Pagen.), greatly enlarged. (After Parrott.)

binocular is most convenient for locating them. They are usually whitish in color (rarely pinkish) with the head and thorax fused and with a much longer, ringed, tapering abdomen. The two pairs of legs are found under the forward end of the body. (See figure 1.)

ORIGIN AND DISTRIBUTION OF THE MITE

Of all the mites on deciduous fruits the pear leaf blister mite is the most abundant. It causes great damage to pear and apple throughout the world. It is of European origin and was probably introduced into the United States on nursery stock. It is recorded from Canada, Russia, Turkey, Bessarabia, Italy, Norway, Sweden, France, Poland, Holland, England, Ireland, Argentina, Denmark, Germany, Australia, Scotland, Switzerland, Tasmania, South Africa, Spain, Ukraine, and New Zealand.

It was first recorded in America in 1872, and from then on it was recognized in nearly every state where pears and apples are grown, both in the United States and Canada. It was reported in pear orchards in California in 1895 but, so far as is known, it was not until the past few years that it caused damage other than the blistering of the fruit and foliage. Until last fall no mention was made of it as a pest on apples in California, though in Oregon, Washington, and elsewhere it has become a serious pest of apples within the past ten years.

HOST PLANTS

Besides the apple and pear, which are commonly infested in both Europe and America, it has been found on service berry, cotoneaster, white beam tree, European mountain ash, and the wild service tree. Snowberry may be the native host in the Pacific Northwest.

The varieties of pears observed to be infested in California are Bartlett, Hardy (Buerre Hardy), Comice, d'Anjou, Winter Nelis, and Bosc (Buerre Bosc).

The varieties of apples so far found to be infested are Gravenstein, Delicious, and Jonathan.

INJURY

The blisters found on pear and apple foliage are generally recognized by most orchardists. They have been fully described and are very prevalent. The injury to fruit buds is rapidly coming to the attention of growers throughout the state because of the increasing percentage of buds that are lost each year. In heavy infestations the fruit buds turn brown early in the winter and frequently flare open (fig. 2). During the winter the buds drop readily when touched and are so dry that they may be rubbed to a fine chaff between the thumb and first finger. At pruning time many of the buds fall off when the cut brush is being removed from the tree. At blooming time many of the fruit buds fail to open at all, others open with only one or two blossoms and the bloom is weak, often fails to set, and frequently drops.

Mite damage may be so severe during the winter months as to leave practically no buds to open in the coming spring, as was the case in parts of Sonoma County in 1930 and in parts of Napa County in 1931. In other localities over 80 per cent of the fruit has had to be classed as culls, as in Contra Costa County in 1930. Very seldom are there more than 50 per cent of No. 1 pears at harvest time in a mite-infested orchard. The subsequent feeding on new growth shows no apparent damage.

The work of the mites around the floral parts may result in misshapen fruit that is usually badly russeted. Not all misshapen fruit can be attributed to mite work, as there are other factors causing it. Thrips frequently cause similar damage to bloom and fruit. Fruit produced from buds on old spurs is more likely to be "round," and there is apparently a difference in length of the fruit in different localities.

No blistering of the leaves was noted on the apples in the Sebastopol district, though many unopened dead fruit buds were observed. In a considerable number of trees limbs were found on which practically all of the buds were killed during the winter and no fruit or foliage was produced. These bare limbs were later usually badly sunburned. The fruit was reported to be about normal, although there was more russeting than usual. These infestations are apparently just beginning and are likely to become much more serious as the infestation develops.

Fig. 2.—Mite-injured bud on the left; normal bud on the right.

LIFE HISTORY

The mites enter the first bud scales during the period from August to the early part of October, according to the locality and temperature. In the higher altitudes, such as the Sierra foothills and the Santa Cruz Mountains, the mites enter the buds nearly a month earlier than they do in some of the San Francisco Bay counties. This may be due to a lower mean temperature at these higher altitudes.

During the migratory period (August–September) they are pinkish in color and will be found clustered about the leaf buds behind the bases of the leaf stems on new growth. At this time they are quite

exposed, and therefore this period is apparently the most practical time to destroy them.

After they are hidden under the fruit-bud scales they are white in color and tend to collect in groups. At this time it is almost impossible to destroy them with most sprays without injuring the fruit buds because they are so well protected. Egg deposition soon starts within the bud and the mites mature, continue to multiply, and work deeper and deeper into the bud throughout the winter. They feed on and destroy the white tissue at the base of the bud scales and later on the floral parts enclosed in the bud.

When the remaining live buds open in the spring the mites leave the cluster buds and feed upon the young tender new growth and soon establish themselves in the leaf axils. They work out on the new growth as it develops until about the middle of June, when oviposition and most of their other activities stop. During the warm period of June, July, and August there is little or no activity, and not until the evenings are cooler again are they found clustering about the leaf buds in their fall migration toward the fruit buds. There are apparently several generations a year, though considerable more work must be done to establish the complete life history.

The principal differences in the two forms of the mite are listed below:

Activity and control	Bud form	Blister form
Oviposition period	September to June.	March to October.
Activity in winter months	Actively feeding and reproducing.	Hibernating; no activity until buds begin to open.
Attack at bloom time	May cause russeting and short-length fruits.	Fruit and leaves blistered.
Early spring	First on new foliage; later in axils of new growth; no blisters.	Attacks under surface of new foliage causing reddish blisters.
Late spring and summer	On axils of new growth; inactive June, July, part of August.	Blistering spreads to all new growth; often defoliation of old leaves occurs.
Early fall	Activity starts in August with migration toward fruit bud.	Many drop with foliage; migration to buds September to November.
Spraying	Must be done before mites enter buds; sprays at other times ineffective.	November or March sprays prevent blistering of fruit and leaves.

A PREDATORY MITE

At least one predator materially assists in destroying the pear leaf blister mite. A tiny white mite, *Sejus pomi* (fig. 3), moves most actively about the infested parts and has been observed to enter through the opening of a blister and destroy several blister mites before leaving. It also works behind bud scales and leaf-stem bases where it can and often does, if sufficiently numerous, completely wipe out a blister-mite infestation.

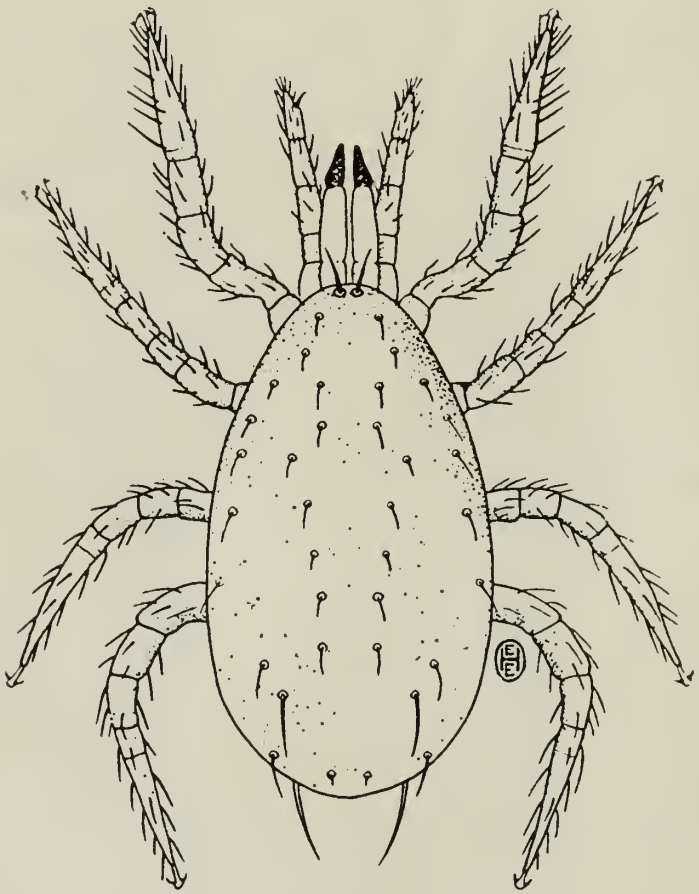

Fig. 3.—*Sejus pomi* Parrott, a mite predatory on the blister mite. (After Ewing.)

In several orchards which were severely infested one season, few, if any, blister mites were found the following season; but numbers of predatory mites were present. It is, therefore, generally assumed that this mite plays an important rôle in keeping the blister mite in check.

CONTROL

The usual spray program for the control of the pear leaf blister mite in the late fall with lime-sulfur or the application of the same material as a cluster bud spray in the spring does not stop the damage to fruit buds or fruit. Since the mites enter the fruit buds

as early as August and September and since it is next to impossible to destroy them once they are deep in the bud, applications in late October or November could not be expected to prevent the new bud type of damage.

The migratory period in August and September seems to be the most logical time for control applications, even though the trees are in foliage. The success of the treatment depends upon destroying the mites before they enter the fruit buds. In some localities this will mean spraying just as soon as the crop is removed; in others the applications should be made during early September. The proper timing of the applications in any particular locality can only be determined by careful inspection to determine the status of the mite in that locality.

The foliage and fruit buds will stand the dosage here recommended if applied under normal conditions as to temperature, soil moisture, north wind, etc. Some orchards may show a somewhat earlier defoliation than usual, but this is not considered serious. In no case has bud injury from the spray been noted.

In the fall of 1930 experimental plots were treated at Highlands, Santa Cruz County; Walnut Creek, Contra Costa County; and Suisun Valley and Vaca Valley, Solano County. Although the mites were fairly well under the bud scales in some of the plots at the time of application (September to November), some interesting data were obtained. The materials used were as follows:

2 per cent light oil emulsion[2] plus ½ pint Black Leaf 40 to 100 gallons of spray
2 per cent light oil emulsion
2½, 5, 7½, and 10 per cent lime-sulfur solution
5 per cent lime-sulfur and 5 per cent heavy oil emulsion[3]
7 per cent lime-sulfur and 3 per cent heavy oil emulsion
3 per cent and 5 per cent miscible oil
2 per cent light oil emulsion and 5 per cent lime-sulfur
2 per cent light oil emulsion and 7 per cent lime-sulfur

In none of the plots where the mites were starting to enter the fruit buds did the 2 per cent light oils or the 2½ per cent or 5 per cent lime-sulfur show appreciable results. The 7½ and 10 per cent lime-sulfur applications killed many mites and gave about 50 per cent increase in the amount of No. 1 pears harvested the next season. All of the oil and lime-sulfur combinations gave a satisfactory kill of

[2] The viscosity of the oil here referred to as "light" was 65 seconds Saybolt, and the unsulfonated residue was 90 per cent.

[3] The viscosity of the oil here referred to as "heavy" was 105 seconds Saybolt, and the unsulfonated residue was 65 per cent.

mites considering the fact that many mites were already under the bud scales; and the fruit the following season was decidedly better. The effect on the percentage of No. 1 fruit in each plot could not be obtained, because of thrips damage in the spring of 1931. However, judging from the percentage of good buds that came through the winter, the nature of the bloom, and the condition of the buds this fall, the following conclusions were drawn:

Lime-sulfur 7½ to 10 per cent, if applied sufficiently early, before too many mites are in the buds, as determined by careful observations, will give a satisfactory control.

Five per cent lime-sulfur plus 2 per cent light oil emulsion gives a better control later on under most conditions.

Three of the plots received either 5 per cent or 10 per cent lime-sulfur over part of the area in the spring as a cluster spray, but this application apparently did not effect control of the mite work. In many districts, however, a lime-sulfur application in the cluster period is required for scab control and should not be omitted.

Early fall sprays for mite control will usually kill immature scale and brown mite eggs so that the usual dormant treatment may be omitted.

Pruning of the new growth terminals and also of sucker growth inside the tree undoubtedly removes many of the mites infesting the terminal buds and leaf axils. In Sonoma County the early pruning of inside sucker growth has been observed to reduce these sources of reinfestation very greatly.

The timing of the spray applications in 1931 brought out more forcibly the variation in the migratory period of the mite. Again the orchards in the high altitudes were weeks ahead of the valley orchards. The mites were well into the buds in August in Placerville, even before the fruit was all picked. The Carneros district in Napa County was just in the proper condition for spraying the first week in September. Contra Costa County orchards were not ready until late September.

Applications in 1931 were of lime-sulfur (7½ and 10 per cent) and the oil and lime-sulfur combination recommended above. The lime-sulfur applications killed mites outside of the buds and even a few in the looser buds early in the fall. The oil and lime-sulfur applications in Napa County, Solano County, and Contra Costa County gave satisfactory control with a minimum of buds destroyed during the following winter.

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